Vendor Performance Analytics Report

1. Exploratory Data Analysis (EDA)

Summary Statistics

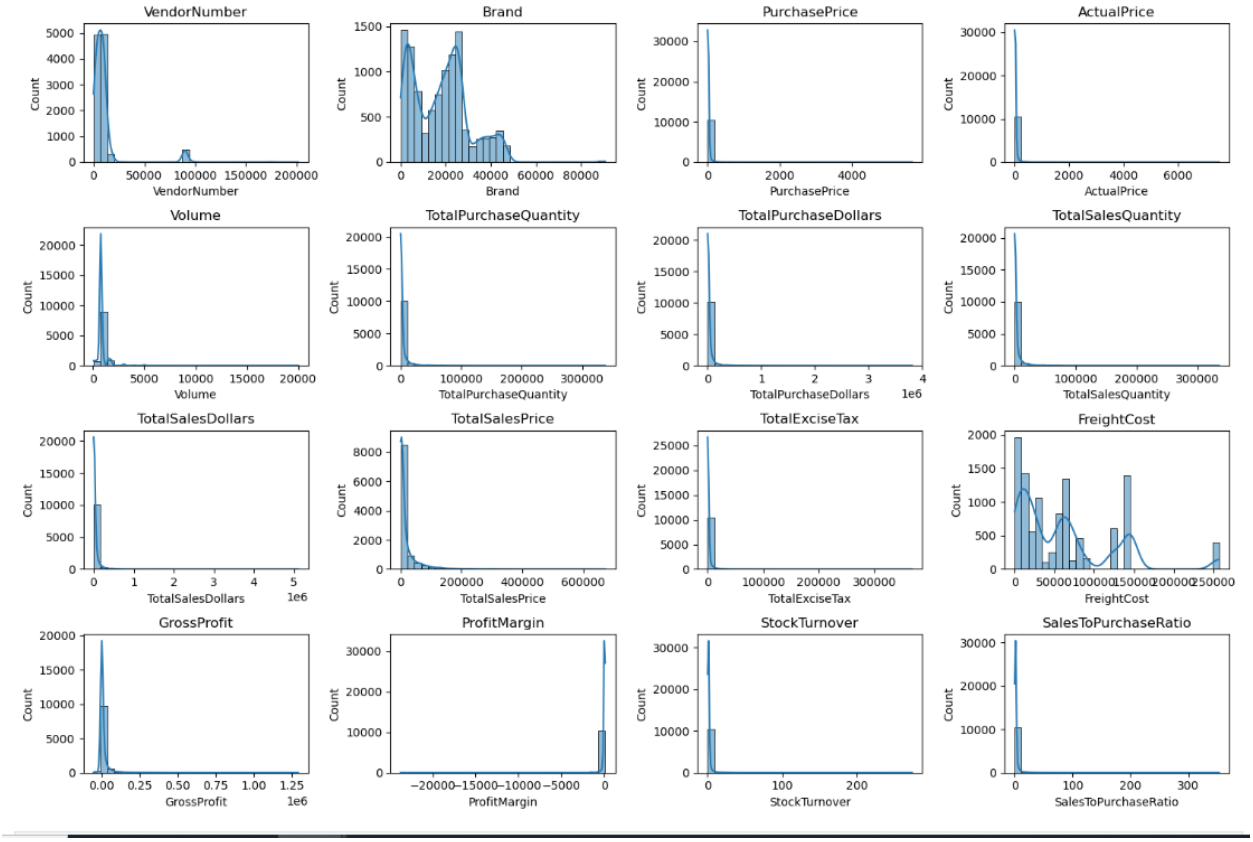
```
# summary statistics
df.describe().T
```

	count	mean	std	min	25%	50%	75%	max
VendorNumber	10692.0	1.065065e+04	18753.519148	2.00	3951.000000	7153.000000	9552.000000	2.013590e+05
Brand	10692.0	1.803923e+04	12662.187074	58.00	5793.500000	18761.500000	25514.250000	9.063100e+04
PurchasePrice	10692.0	2.438530e+01	109.269375	0.36	6.840000	10.455000	19.482500	5.681810e+03
ActualPrice	10692.0	3.564367e+01	148.246016	0.49	10.990000	15.990000	28.990000	7.499990e+03
Volume	10692.0	8.473605e+02	664.309212	50.00	750.000000	750.000000	750.000000	2.000000e+04
TotalPurchaseQuantity	10692.0	3.140887e+03	11095.086769	1.00	36.000000	262.000000	1975.750000	3.376600e+05
TotalPurchaseDollars	10692.0	3.010669e+04	123067.799627	0.71	453.457500	3655.465000	20738.245000	3.811252e+06
TotalSalesQuantity	10692.0	3.077482e+03	10952.851391	0.00	33.000000	261.000000	1929.250000	3.349390e+05
TotalSalesDollars	10692.0	4.223907e+04	167655.265984	0.00	729.220000	5298.045000	28396.915000	5.101920e+06
TotalSalesPrice	10692.0	1.879378e+04	44952.773386	0.00	289.710000	2857.800000	16059.562500	6.728193e+05
TotalExciseTax	10692.0	1.774226e+03	10975.582240	0.00	4.800000	46.570000	418.650000	3.682428e+05
FreightCost	10692.0	6.143376e+04	60938.458032	0.09	14069.870000	50293.620000	79528.990000	2.570321e+05
GrossProfit	10692.0	1.213238e+04	46224.337964	-52002.78	52.920000	1399.640000	8660.200000	1.290668e+06
ProfitMargin	10692.0	-inf	NaN	-inf	13.324515	30.405457	39.956135	9.971666e+01
StockTurnover	10692.0	1.706793e+00	6.020460	0.00	0.807229	0.981529	1.039342	2.745000e+02
SalesToPurchaseRatio	10692.0	2.504390e+00	8.459067	0.00	1.153729	1.436894	1.665449	3.529286e+02

Key insights:

- **Gross Profit:** Minimum of -52,002.78, showing potential losses due to high costs or heavy discounts (selling below purchase price).
- **Profit Margin:** Minimum of -∞, suggesting cases where revenue is zero or lower than cost, leading to extreme negative margins.
- **Total Sales Quantity & Dollars:** Some products purchased but never sold, pointing to slow-moving/obsolete stock.
- **Outliers:** High deviations in purchase/actual prices, excise tax, and freight cost (premium product categories).

Distribution Analysis



Findings:

- Skewed distributions across most variables (e.g., sales and purchases highly concentrated in lower ranges).
- Freight costs show wide variation across vendors, indicating inconsistent logistics/shipping charges.
- Profit margins mostly cluster in the positive range but with several negative outliers.

Negative & Zero Values Analysis

Summary Statistics Insights

Negative & Zero Values:

- **Gross Profit**: Minimum value is `-52,002.78`, indicating losses. Some products or transactions may be selling at a loss due to high costs or selling at discounts lower than the purchase price.

- **Profit Margin**: Has a minimum of `-∞`, which suggests cases where revenue is zero or even lower than costs.
- **Total Sales Quantity & Sales Dollars**: Minimum values are `0`, meaning some products were purchased but never sold. These could be slow-moving or obsolete stock.

Outliers Indicated by High Standard Deviations:

- **Purchase & Actual Prices**: The max values (`5,681.81` & `7,499.99`) are significantly higher than the mean (`24.39` & `35.64`), indicating potential premium products.
- **Freight Cost**: Huge variation, from `0.09` to `257,032.07`, suggesting logistics inefficiencies or bulk shipments.
- **Stock Turnover**: Ranges from `0` to `274.5`, implying some products sell extremely fast while others remain in stock indefinitely.
    - Value more than `1` indicates that sold quantity for that product is higher than purchased quantity, possibly because sales are being fulfilled from older stock

Data Filtering Applied

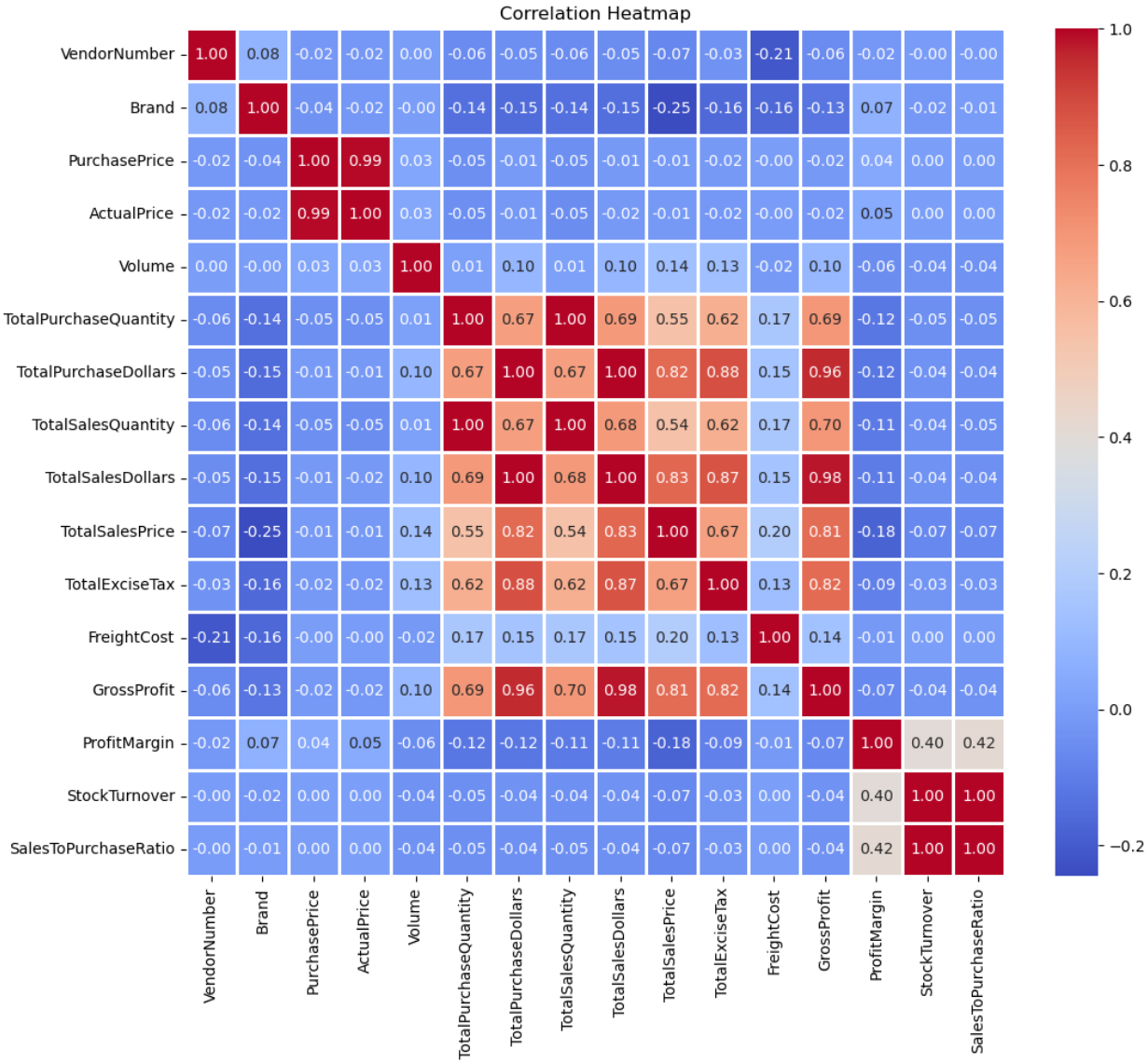
To ensure reliable insights, the following records were removed:

- **Gross Profit ≤ 0** → excluded loss-making transactions.
- **Profit Margin ≤ 0** → excluded unprofitable vendors.
- **Total Sales Quantity = 0** → eliminated stock never sold.

---

2. Correlation Insights

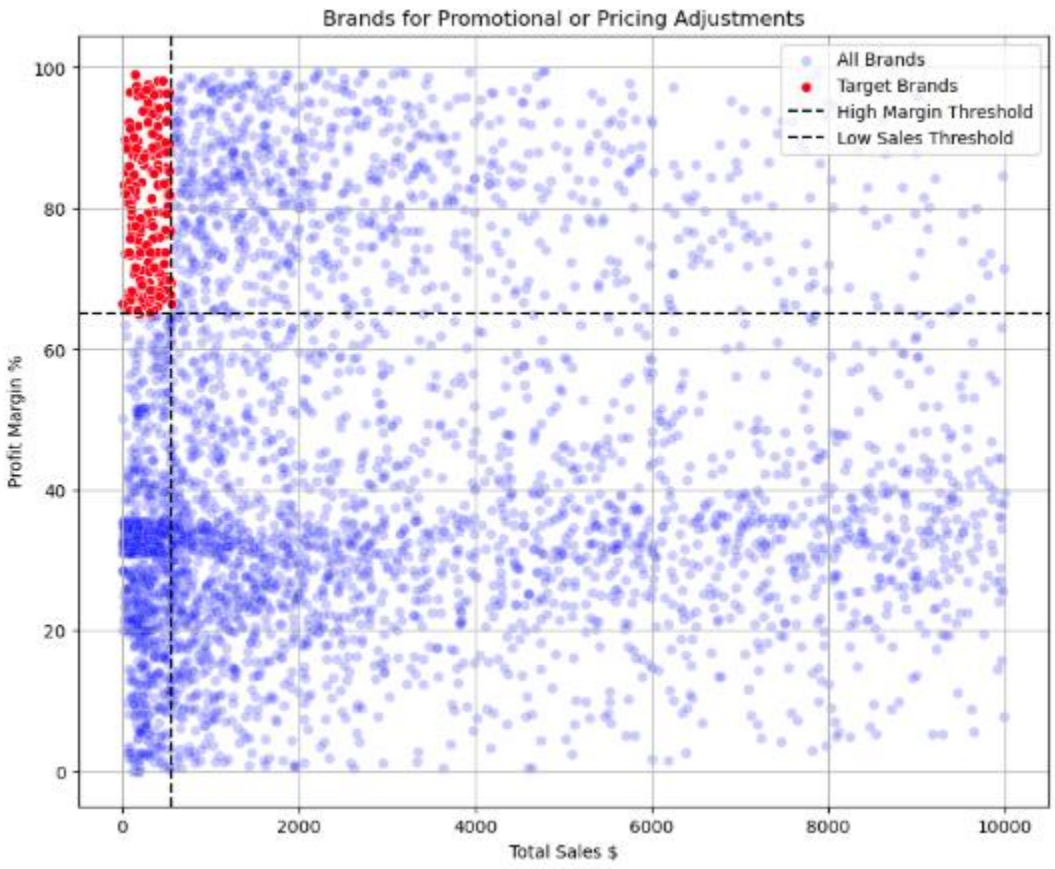
Heatmap



- **Purchase Price vs. Sales/Gross Profit:** Very weak correlation (≈ -0.01), suggesting price differences don't strongly impact profitability.
- **Total Purchase Quantity vs. Total Sales Quantity:** Extremely strong correlation (0.999), confirming inventory efficiency.
- **Profit Margin vs. Sales Price:** Negative correlation (-0.179), indicating higher prices may reduce margins due to competition.
- **Stock Turnover vs. Profitability:** Weak correlation, meaning faster stock movement doesn't always translate to higher profits.

3. Research Questions & Key Findings

Q1: Brands for Promotional or Pricing Adjustments



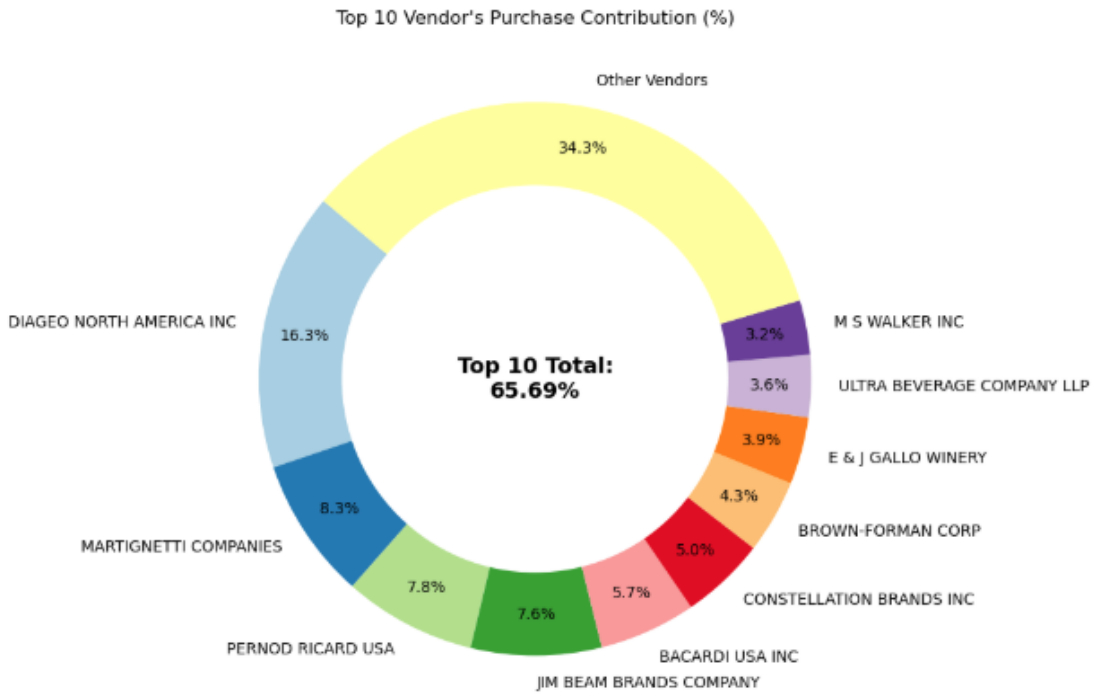
- Identified **brands with low sales but high profit margins** (e.g., Santa Rita Organic, Crown Royal Apple, Nanbu Bijin Southern Beauty).
- Action: These brands are strong candidates for **promotional push** or **pricing adjustments** to boost sales without sacrificing profitability.

1. Brands with Low Sales but High Profit Margins

- Identified **198 brands** with low total sales but high profit margins (avg. 65–90%).
- These brands can benefit from **targeted marketing, promotional campaigns, or price optimizations** to increase sales volume without compromising profitability.

---

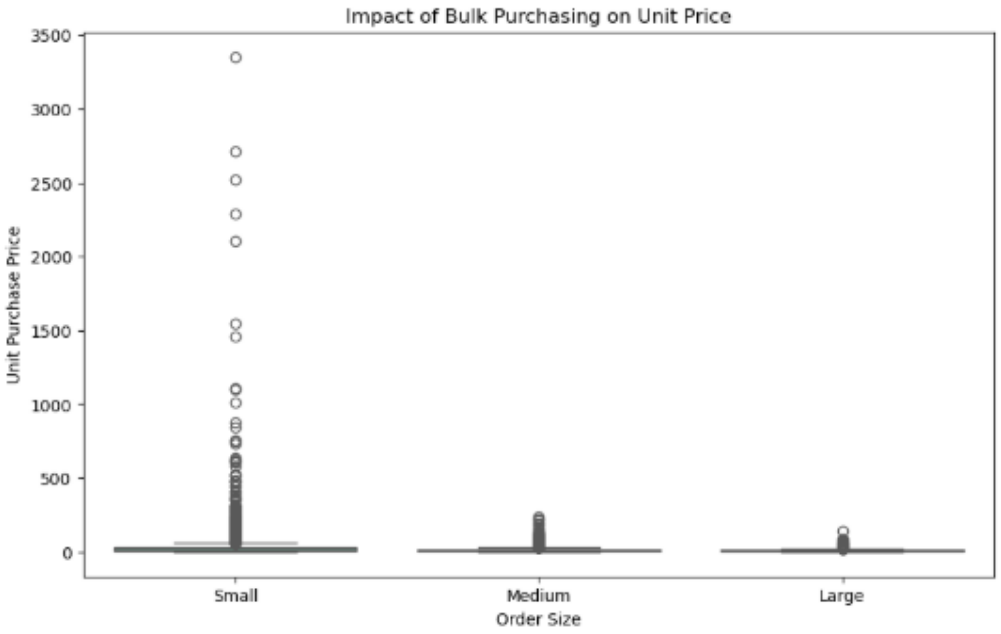
2. Top Vendors by Sales & Purchase Contribution



- The **Top 10 vendors contribute ~65.7%** of total purchases, leaving 34.3% spread across all other vendors.
- This **over-reliance** on a few vendors creates **supply chain risks** (e.g., disruption, bargaining power).
- Recommendation: Diversify vendor portfolio to reduce dependency.

---

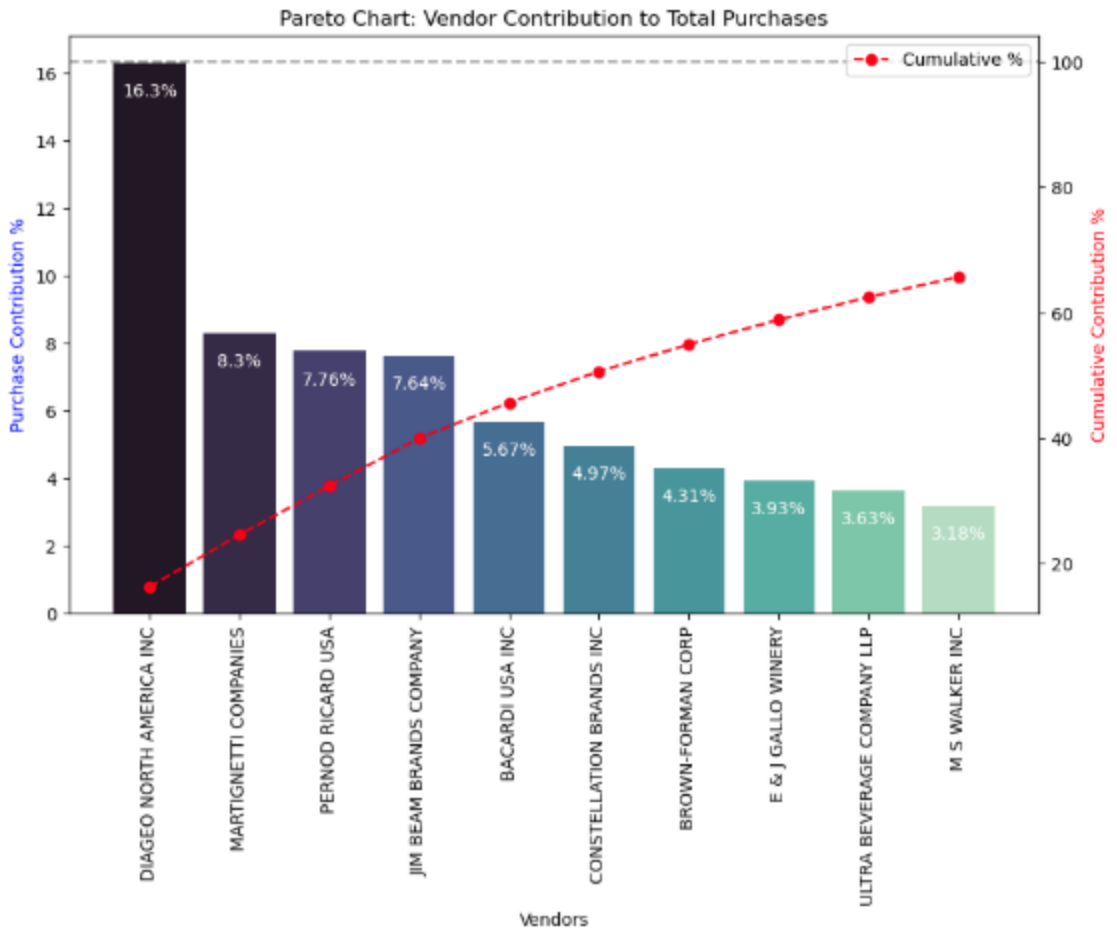
3. Impact of Bulk Purchasing on Cost Savings



- Bulk purchasing reduces per-unit costs significantly:
  - Small Orders: ~$39/unit
  - Medium Orders: ~$15/unit
  - Large Orders: ~$11/unit
- **72% lower cost** achieved in bulk orders compared to small orders.
- Insight: Encourage **bulk pricing strategies** to maximize profitability and sales.

---

4. Vendors with Low Inventory Turnover

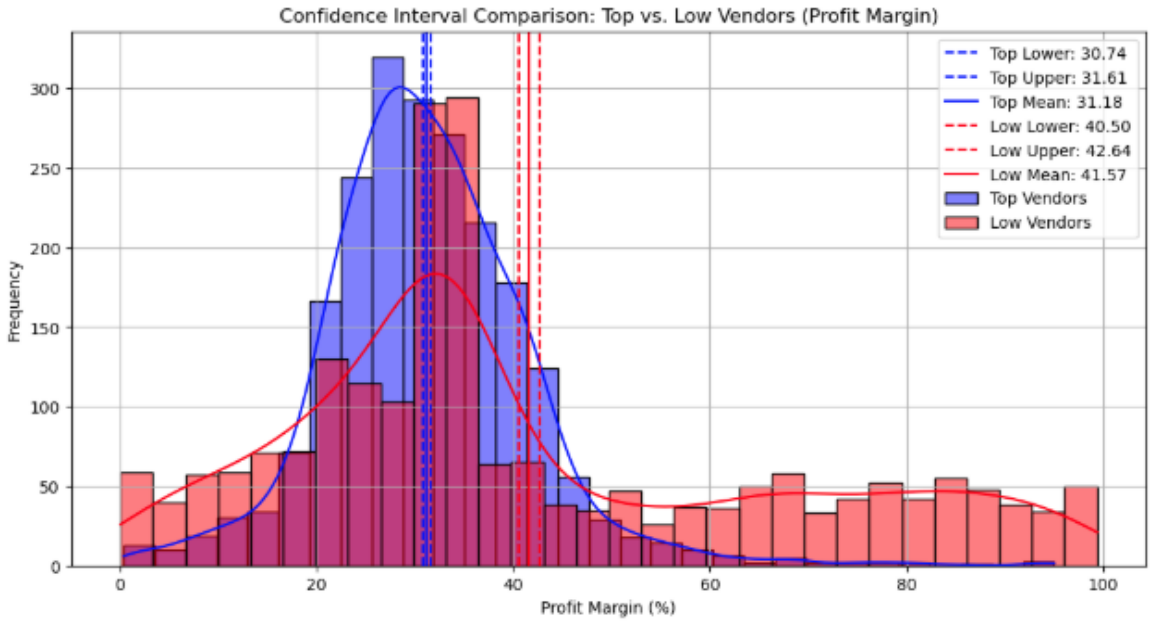


- **Unsold Inventory Capital = $2.71M** locked in slow-moving vendors.
- Slow turnover increases storage costs, reduces liquidity, and impacts overall profitability.
- Recommendation: Focus on better stock management, renegotiating order terms, and demand forecasting.

---

5. Profit Margin Comparison (High vs. Low Performing Vendors)

- **Top Vendors' Profit Margin (95% CI):** 30.74% – 31.61% (Mean: 31.17%)
- **Low Vendors' Profit Margin (95% CI):** 40.48% – 42.62% (Mean: 41.55%)
- Observation: Low-performing vendors have higher margins but lower sales, suggesting **pricing inefficiencies or limited market reach**.



Actionable Insights:

- **Top Vendors:** Adjust pricing, reduce operational costs, or create bundled promotions to improve profitability.
- **Low Vendors:** Invest in marketing, expand distribution networks, and optimize pricing strategies to improve sales volume.

5. Statistical Validation

- **Hypothesis testing (t-test)** confirms a **significant difference** in profit margins between top and low vendors.
- 📌 **Implication**:
  - High-margin vendors → benefit from **pricing adjustments**.
  - Top-selling vendors → should focus on **cost efficiency**.

Is there a significant difference in profit margins between top-performing and low-performing vendors?

Hypothesis:

- **H_0 (Null Hypothesis):** There is no significant difference in the mean profit margins of top-performing and low-performing vendors.
- **H_1 (Alternative Hypothesis):** The mean profit margins of top-performing and low-performing vendors are significantly different.

[40]:
```
#Perform Two-Sample T-Test
t_stat , p_value =ttest_ind(top_vendors,low_vendors,equal_var=False)
#Print Results
print(f"T-Statistic: {t_stat:.4f}, P-Value: {p_value:.5f}")
if p_value<0.05:
    print("Reject Null Hypothesis")
else:
    print("Fail to Reject Null Hypothesis")
```

```
T-Statistic: -17.6695, P-Value: 0.00000
Reject Null Hypothesis
```

Final Recommendations

- **Diversify vendor partnerships** → mitigate supply chain risks.
- **Leverage bulk purchasing** → competitive pricing + efficient inventory management.
- **Optimize slow-moving inventory** → adjust order sizes, launch clearance sales, or revise storage strategies.
- **Enhance marketing & distribution** → boost sales of low-performing vendors without hurting margins.
- **Re-evaluate pricing** → for low-sales, high-margin brands to **increase volume without sacrificing profit**.